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Structure and Mechanical Properties of Compressed Sodium Aluminosilicate Glasses

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Understanding the effect of pressure on the structure of aluminosilicate glasses is important for understanding the densification mechanism of these materials under pressure and the corresponding changes in macroscopic properties. Here, we study pressure-induced changes in density, network structure, indentation hardness, and crack resistance of sodium aluminosilicate glasses with varying Al/Si ratio and thus non-bridging oxygen (NBO) content before and after isostatic compression at 1 GPa at T_g . The effect of increasing NBO content is network depolymerization, higher atomic packing factor, lower hardness, and higher crack resistance. High-NBO glasses have a larger ability to densify upon compression and exhibit larger pressure-induced changes in mechanical properties. The ^{27}Al NMR data show a surprising presence of five-fold aluminum in the as-made high-NBO glasses, with additional formation upon compression. Our study therefore provides insights into the relationship between Al coordination and NBO content in aluminosilicate glasses and how it affects their densification behavior.